IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.	:	09/779,076	Confirmation No. 7830
Applicant	:	James M. Rochelle, et al.	
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Assignee	:	Concorde Microsystems, Inc.	
Title	:	Wireless Boundary Proximity Determining and Animal Containment Apparatus and Method	
Declarant	:	Dr. James M. Rochelle	

DECLARATION OF DR. JAMES M. ROCHELLE UNDER 37 C.F.R. § 1.132

1. I, Dr. James M. Rochelle, declare as follows, under penalty of perjury.

2. I hold a Ph.D. in Electrical Engineering from The University of Tennessee (1974). I have had a total of 50 journal articles and technical reports published and 38 years experience as a practicing engineer and educator. I am a member of Tau Beta Pi, Phi Kappa Phi, Eta Kappa Nu, and the IEEE.

3. My position at Concorde Microsystems of Knoxville, Tennessee, is Vice-President of ASIC Development. I am one of the original founders of Concorde and accepted a full time ASIC design and management position with the company in January, 2001. I was a full time faculty member of The University of Tennessee Electrical and Computer Engineering Department from which I retired in December 2000 after 19 years of research and teaching service. My early practical experience was as a development engineer at the Oak Ridge National Laboratory (ORNL) with both design and management responsibility for a wide variety of electronics and

instrumentation projects including high temperature electronics for in-core nuclear reactors, high energy capacitor bank design, general nuclear and radiation electronics, miscellaneous ultrasonic instruments, and micropower transmitters for wildlife telemetry applications.

4. I have reviewed Application Serial Number 09/779,076, filed on February 7, 2001, and titled "Wireless Boundary Proximity Determining and Animal Containment Apparatus and Method."

5. I have reviewed United States Patent Number 6,392,547, entitled "Proximity Monitoring System and Associated Methods," issued to Stewart, et al., on May 21, 2002 ("the '547 patent" or "Stewart").

6. Among the wireless containment and proximity monitoring systems with which I was familiar prior to the filing date of Application Serial Number 09/779,076, were devices of the type shown in the patent listed in paragraph 5.

7. I have reviewed the U.S. Patent and Trademark Office action, Paper Number 13, Application Serial Number 09/779,076, which contains the following statement on pages 2-4:

> Regarding Claims 1-3, 15, and 28, Stewart et al show a proximity monitoring system capable of accurate boundary detection independent of orientation comprising, a transmitter 21 including an antenna array 32, 33 that continuously generates a magnetic field based on the transmitted electrical signal and having an intensity within the area 23 and defining a boundary 24, a receiver module 25 including an antenna array 53-55 responsive to the magnetic field, in any direction and connected to a single channel receiver 56 and a measurement circuit for determining a total power of the magnetic field incident at the antenna array, all arranged as claimed. Although Stewart et al do not specifically call the processor 61 a "measurement circuit", column 5, lines 30-53 suggest to the skilled artisan that the processor performs a number of different functions. It would have been obvious to the skilled artisan that the processor must determine the total power or signal strength at the antennas 53-55. The three antennas are oriented in three distinct and different axes, and thus the total power is connected to a common node connected to the detector 56 connected to the demodulator 60 and connected to processor 61. Stewart et al discuss the intensity threshold

indicative that the receiver tag 25 is proximate the base station 21 within the perimeter 24. One skilled in the art recognizes as obvious that there is a measurement circuit implied in the circuitry since there is a preset threshold power level employed in the system. A skilled artisan would find it obvious that the threshold power level is achieved by measurement of the total power incident at the antenna array. The acknowledgement detection function (col. 5, lines 51-54) cannot be performed without the total power incident on the antenna array being measured. Regarding Claims 4-6, 12-14, it would have been obvious to the skilled artisan to employ three transmitting antennas and/or two receiver antennas, and notice of such use is hereby taken. As to Claims 7 and 28, the line frequency multiple defining the carrier frequency is an obvious method used in transmitters. As to Claims 8, 15-23, the oscillator and PLL and amplifiers, etc., are all obvious transmitter components in the Stewart et al system, and would therefore be obvious to employ therein, by the skilled artisan. As to Claims 9-11, the particular modulation technique is also obvious to the skilled artisan.

. . . Specifically, there is motivation in the Stewart et al. reference for a measurement circuit because a skilled artisan recognizes as obvious the function of the circuitry in the Fig. 4 of Stewart et al provides for measuring the total power of the incident magnetic field by virtue of the magnetic field circuit 56. There is a threshold defined for this circuit. Thus, a measurement of the incident field is a requirement for the circuit to operate. Additionally, the single channel receiver is certainly provided by Stewart et al as there are no frequency changes. These systems operate on a single frequency. Since all claimed structure is shown to be obvious in Stewart et al for providing the claimed functions, the claims at hand are not seen to patentably define thereover.

8. The statement from the Examiner quoted in Paragraph 7 includes several assertions that are incorrect, in view of the state of the wireless pet containment and proximity monitoring art as of the filing date of Application Serial Number 09/779,076. These statements are discussed below in detail.

9. The statement from the Examiner quoted in Paragraph 7 includes the incorrect statement that "It would have been obvious to the skilled artisan that the processor must determine the total power or signal strength at the antennas 53-55. The three antennas are oriented in three distinct and different axes, and thus the total power is connected to a common node connected to the detector 56 connected to the demodulator 60 and connected to processor 61." As of the filing date of Application Serial Number 09/779,076, one skilled in the art of proximity monitoring systems

would not have considered that the processor must determine the total power or signal strength at the antennas as obvious for the following reasons:

10. Stewart shows the signals generated by three sensor coils to be directly parallel-connected thus causing the sensor signals to be linearly combined into a single antenna signal which is detected, demodulated, and processed. It can be shown that the composite signal obtained by a linear superposition of the individual signals generated by each of a plurality of coils (Stewart shows three), all sensing the same field, is exactly equivalent to the signal that would be generated by a single coil which is the equivalent vector combination of the plurality of coils. For example, if Stewart's antenna is interpreted to be three mutually orthogonal coils, each with sensitivity, K, and respectively aligned to have positive polarity along a XYZ coordinate frame of reference, then the linearly combined composite response will be exactly the same as the response that would be generated by a single coil having sensitivity $K\sqrt{3}$ and having its positive axis aligned along a vector direction defined by $(\mathbf{u}_x + \mathbf{u}_y + \mathbf{u}_z)$. Therefore, the directionality or orientation dependence of Stewart's antenna is identical with the orientation dependence of this equivalent single coil. In particular, if Stewart's two transmitter coils are assumed to each have a principal axis in the horizontal plane, then no vertical magnetic field component will exist anywhere in the horizontal plane. Thus, if Stewart's antenna is oriented such that its vector equivalent axis is vertical, then zero signal is detected, i.e., a null response is generated. Clearly, Stewart does not teach a system that has accurate 3-D boundary detection independent of orientation. Similarly, since Stewart's antenna response is equivalent to that of a single coil, it is does not in general produce a signal from which total power of a 3-D magnetic field can be determined by any means.

11. Accordingly, therefore, to one skilled in the art at the time of filing of the Application Serial Number 09/779,076, it was not obvious that Stewart teaches a processor for determining total power, or even a reasonable approximation of total power, independent of orientation.

12. The statement from the Examiner quoted in Paragraph 7 includes the incorrect statement that "Regarding Claims 4-6, 12-14, it would have been obvious to

the skilled artisan to employ three transmitting antennas and/or two receiver antennas, and notice of such use is hereby taken." As of the filing date of Application Serial Number 09/779,076, one skilled in the art of proximity monitoring systems would not have considered the use of three transmitting antennas and/or two receiver antennas as obvious for the following reasons:

13. Stewart teaches "the base station **21** may include a housing **30**, a printed circuit board **31** within the housing and a pair of wire coils **32**, **33** carried by the housing. The base station **21** illustratively includes rotating magnetic field generating circuitry **35** on the circuit board **31**. This circuitry **35** may include a driver **41** for driving the wire coils **32**, **33** at a desired power level and frequency. The driver **40** may energize the coils **32**, **33** at a frequency, such as in a range of about 60 KHz to 400 Khz. In addition, the size of the coils **32**, **33** may be sufficiently small relative to the wavelength so that the rotating magnetic field is generated while substantially no electric field is generated. For example, the coils **32**, **33** can have a diameter of less than about one foot. Other coil sizes and operating frequencies are also contemplated by the present invention." Stewart, Col. 3, line 59 to Col. 4, line 6; *see also* Figs. 2 & 3. Stewart does not teach or disclose the use of three transmitting antennas at the base station.

14. Stewart explicitly teaches the use of a rotating magnetic field as created by the rotating magnetic field generating circuitry **35**. Stewart, Col. 3, lines 62-64; *see also* Col. 4, lines 7-11. Rotating magnetic fields are produced by applying signals to two coils with the signals out of phase by the same amount that the coils are aligned about a common axis. In other words, two orthogonal coils will generate a rotating magnetic field when the two coils each are excited with an alternating current that is 90 degrees out of phase. As a result of the rotating magnetic field, the signal induced in a sensor coil reflects a signal strength dependent only on the distance from the generating coils and independent of orientation.

15. Further, Stewart teaches " The rotating magnetic field generator, illustratively provided by the coils **32**, **33** and associated generating circuitry **35**, generates a rotating magnetic field radiating outwardly to define the proximate area **23** which extends to the perimeter **24**. The magnetic field penetrates common building materials and other impediments that could greatly effect an electromagnetic or RF field as will be appreciated by those skilled in the art. In addition, the magnetic field decreases in intensity relatively quickly and therefore may be used to provide a relatively sharply defined perimeter **24**. . . . The rotating magnetic field may be circularly polarized to thereby provide a generally circular proximate area **23** and associated perimeter **24** as shown perhaps best in FIG. 1. In other embodiments, elliptical or other polarizations could also be used to define different shapes for the proximate area." Stewart, Col. 4, lines 7-25; *see also* Fig. 1. Stewart does not teach or disclose that the area **23** is a volume or that the perimeter **24** is anything other than a two-dimensional perimeter **24**. Neither does Stewart teach, disclose, or even hint that it would be desirable to maintain the perimeter **24** over a three-dimensional volume of space such that coverage over uneven terrain would be provided. Stewart does not discuss or identify the problem of a planar perimeter **24** with respect to uneven terrain.

16. It would not have been obvious to one of ordinary skill in the art of proximity monitoring systems at the time of filing of the Application Serial Number 09/779,076 to employ three transmitting antennas. First, Stewart does not teach, disclose, or hint at the use of three transmitting antennas. Second, Stewart teaches a rotating magnetic field, which is not the same as an ordinary magnetic field having no circular rotation. Third, a combination of three transmitting antennas provides a three-dimensional perimeter and such a three-dimensional perimeter is not discussed in Stewart. Fourth, three transmitting antennas solves the problem associated with uneven terrain, and such a problem is not discussed in Stewart. Fifth, good engineering practices dictate that component counts be minimized while still meeting performance specifications. Such good engineering practices dictate that a third transmitting antenna only be used if necessary to satisfy performance specifications.

Stewart does not identify any performance specifications for the base station **21** that require a third transmitting antenna.

17. Accordingly, connecting three antennas to a transmitter was not obvious to one skilled in the art of wireless containment and proximity monitoring systems at the time of filing of the Application Serial Number 09/779,076.

18. Stewart recognizes the need for a three-dimensional antenna array for the mobile tag **25**. "Two typical problems with conventional proximity detection systems are a lack of uniform coverage area and a sensitivity to receiver orientation. The proximity detection system **20** in accordance with the invention reduces these effects by using uniform field generation techniques in conjunction with a tag **25** adapted to make effective use of the field. The magnetic field generated may be a nearly constant amplitude rotating magnetic field vector. The tag **25** orientation sensitivity is thus reduced and the magnetic field detector of the tag further enhances this effect by using a plurality of orthogonal receive coils **53-55** to ensure capturing the largest available signal strength. The outputs of the coils **53-55** are preferably combined to create a uniform output regardless of the tag **25** orientation." Stewart, Col. 5, lines 7-20; *see also* Fig. 4. Stewart does not teach or disclose using less than three coils in the mobile tag **25**.

19. A mobile receiver, such as one attached to a dog collar, needs to be able to receive signals regardless of the dog's orientation to the transmitter. The receiver must allow for the movement of the dog as it turns around and rolls over. Accordingly, the design requirement is for a receiving antenna system responsive to the power or intensity of the transmitted signal regardless of the orientation of the receiving antenna system. Also, the receiving antenna system needs to be as sensitive as possible to that transmitted signal while maximizing the signal-to-noise ratio (SNR).

20. One skilled in the art at the time of the filing of the Application Serial Number 09/779,076 would recognize that having three orthogonal antenna coils connected either in series or parallel would allow for receiving signals without regard to the orientation of the coils to the transmitter. However, such a connection would

not be optimum for maximizing the signal strength nor for maximizing the SNR. (See my discussion in paragraph 10.) It is customary to match the impedance of antenna coils to the receiver input. By having a single coil matched to a receiver, the detected signal strength and the SNR are maximized when the coil is properly oriented to the transmitter. By splitting that single coil into three orthogonal coils while maintaining an impedance match, the signal strength and the SNR are decreased because, as discussed in paragraph 10, the three coils act as a single coil having a sensitivity of $K\sqrt{3}$, where K is the sensitivity of each of the three coils.

21. Accordingly, it was known that increasing the number of receiving antenna coils will allow the antenna coils to detect a transmitted signal regardless of orientation, it was also known that there was a tradeoff with respect to detected signal strength and SNR. However, methods of using three receiving antennas were known. United States Patent Number 5,067,441, titled "Electronic Assembly for Restricting Animals to Defined Areas," issued to Weinstein on November 26, 1991, attached hereto, discloses three orthogonal receiving antennas, each connected to its own receiver. Weinstein discloses that, by non-linearly combining the antenna outputs by taking the square root of the sum of the squares of the receiver outputs, a total field vector is derived. In this manner, Weinstein maximizes the signal strength and SNR for any orientation of the receiving antennas to the transmitter. Weinstein discloses that the three antennas can be arranged in a non-orthogonal configuration with an increase in circuit complexity, but Weinstein does not teach or disclose less than three antennas or more than one antenna per receiver.

22. It would not have been obvious to one of ordinary skill in the art of proximity monitoring systems at the time of filing of the Application Serial Number 09/779,076 to employ two receiving antennas. First, Stewart does not teach, disclose, or hint at the use of two receiving antennas. Second, Stewart teaches how three receiving antennas are necessary to provide reception regardless of orientation. This teaches away from one or two antennas, which indicates that two receiving antennas will not work as envisioned by Stewart. Third, Stewart does not provide details regarding the connection of the receiving antennas, specifically with respect to

whether any particular impedance matching is performed. Fourth, it was not known, at the time of filing of the Application Serial Number 09/779,076, how to construct an antenna array with only two antenna coils that was truly omni-directional in any sense.

23. Accordingly, connecting two antennas to a receiver was not obvious to one skilled in the art of wireless containment and proximity monitoring systems at the time of filing of the Application Serial Number 09/779,076.

24. The statement from the Examiner quoted in Paragraph 7 includes the incorrect statement that "As to Claims 7 and 28, the line frequency multiple defining the carrier frequency is an obvious method used in transmitters." As of the filing date of Application Serial Number 09/779,076, one skilled in the art of proximity monitoring systems would not have considered the use of "line frequency multiple defining the carrier frequency [as] an obvious method" for proximity monitoring systems.

25. Wireless containment and proximity monitoring systems use mobile receivers. These receivers, by the very nature of being mobile, receive interference from power line sources located near the transmitter. The Examiner's assertion fails to take into the consideration that carrier frequencies that are multiples of the power line frequency are very susceptible to interference from power line interference. There are applications in which using multiples of line frequency to determine an operating frequency are used; however, in the field of wireless containment and proximity monitoring systems, such use is not obvious because the power line interference cannot be readily discriminated from the transmitted signal, thereby making it difficult to determine distance from the transmitter.

26. By using very specific modulation and demodulation techniques, it is possible to discriminate and reject interference induced from the power lines. However, such techniques were not known with respect to wireless containment and proximity monitoring systems before the filing date of Application Serial Number 09/779,076.

27. Accordingly, using multiples of the power line frequency to define the carrier frequency was not obvious to one skilled in the art of wireless containment and proximity monitoring systems at the time of filing of the Application Serial Number 09/779,076.

28. The statement from the Examiner quoted in Paragraph 7 includes the incorrect statement that "As to Claims 8, 15-23, the oscillator and PLL and amplifiers, etc., are all obvious transmitter components in the Stewart et al system, and would therefore be obvious to employ therein, by the skilled artisan." As of the filing date of Application Serial Number 09/779,076, one skilled in the art of proximity monitoring systems would not have considered the use of the claimed components as obvious for the following reasons:

29. Stewart teaches that, "The tag **25** illustratively includes a magnetic field detection circuit **56** which, in turn, is connected to a demodulator **60** for at least one of the direction and speed of the rotating magnetic field. By modulating the rotating magnetic field from the base station **21** and demodulating the field at the tag **25**, the tag and base station may be effectively coded together so that the tag is selectively responsive only to the base station to which it is assigned." Stewart, Col. 4, lines 57-65. Stewart does not teach, disclose, or suggest circuits for the magnetic field detection circuit **56** or the demodulator **60**, nor does Stewart teach, disclose, or suggest the components to be used to implement such circuits.

30. Claim 8 includes the limitation to use "a crystal oscillator using a phase locked loop." Claims 16 to 21 include limitations relating to "an I and Q baseband converter" and to "an I and Q baseband amplifier." Stewart does not teach, disclose, or suggest the use of such components in the receiver tag **25**.

31. It would not have been obvious to one of ordinary skill in the art of proximity monitoring systems at the time of filing of the Application Serial Number 09/779,076 to employ either "a crystal oscillator using a phase locked loop" or "an I and Q baseband converter" and "an I and Q baseband amplifier." First, Stewart does not teach, disclose, or suggest the use of such components in the receiver tag **25**.

Second, it was not known in the field of proximity monitoring systems, at the time of filing of the Application Serial Number 09/779,076, to use "a crystal oscillator using a phase locked loop" in a receiver. Third, "a crystal oscillator using a phase locked loop" in the receiver solves the problem of matching the mobile receiver's oscillator frequency to the nominal carrier frequency. Fourth, it was not known in the field of proximity monitoring systems, at the time of filing of the Application Serial Number 09/779,076, to use "an I and Q baseband converter" and "an I and Q baseband amplifier" in a receiver. Fifth, "an I and Q baseband converter" and "an I and Q baseband amplifier" solves the problem of mismatches between the carrier frequency and the receiver's crystal frequency.

32. Accordingly, utilizing the oscillator and PLL and amplifiers, etc., in a receiver was not obvious to one skilled in the art of wireless containment and proximity monitoring systems at the time of filing of the Application Serial Number 09/779,076.

33. The statement from the Examiner quoted in Paragraph 7 includes the incorrect statement that "As to Claims 9-11, the particular modulation technique is also obvious to the skilled artisan." As of the filing date of Application Serial Number 09/779,076, one skilled in the art of proximity monitoring systems would not have considered the use of the claimed modulation techniques as obvious for the following reasons:

34. Claim 9 includes the limitation that "said single carrier signal is modulated using a binary phase shift keying waveform." Claim 10 depends from Claim 9 and includes the limitation that "a coherent said binary phase shift keying waveform is modulated using a waveform produced by integral ratio frequency division of a transmitter system clock." Claim 11 depends from Claim 9 and includes the limitation that "said binary phase shift keying waveform is selected to produce a high degree of rejection of interference at a power line frequency and any significant harmonics of the power line frequency and to allow accurate decomposition of said composite magnetic field into said first magnetic field component, said second magnetic field component, and said third magnetic field component."

35. Stewart states, "base station **21** illustratively includes rotating magnetic field generating circuitry **35** on the circuit board **31**." Stewart, Col. 3, lines 62-64. Stewart also states, "tag **25** illustratively includes a magnetic field detection circuit **56** which, in turn, is connected to a demodulator **60** for at least one of the direction and speed of the rotating magnetic field. By modulating the rotating magnetic field from the base station **21** and demodulating the field at the tag **25**, the tag and base station may be effectively coded together so that the tag is selectively responsive only to the base station to which it is assigned." Col. 4, lines 57-65. Stewart further states, "The coils **53-55**, magnetic field detection circuit **56** and optional demodulator **60** may be considered as providing the magnetic field detector for the tag **25**. The demodulator **60** may be, in turn, connected to a processor **61** or other similar logic circuitry as will be understood by those skilled in the art." Col. 5, lines 1-6. Stewart does not suggest, teach, or disclose the method of modulation between the transmitter base station **21** and the receiver tag **25**.

36. Stewart states, at Column 6, lines 5-24, that:

> The base station **21'** may include a spread spectrum modulator **70** and the tag **25'** may include a spread spectrum demodulator **71**. The other elements of the base station **21'** and tag **25'** are indicated with a prime and are similar to those elements described above and these elements need no further discussion herein. The spread spectrum modulator **70** and demodulator **71** are shown in place of the encoding modulator 41 (FIG. 3) and associated demodulator **60** (FIG. 4), however, those of skill in the art will recognize that in other embodiments, these two types of modulation/demodulation can be used in combination.
>
> As will be readily appreciated by those skilled in the art, the spread spectrum technique may be used to improve performance against the mainly continuous wave interference sources that may be present in the environment. The waveform energy is spread across a wide bandwidth at the base station **21'** and then recombined at the tag **25'**. This has the effect of spreading the interference energy at the tag **25'** across a wide bandwidth allowing it to be filtered out.

37. One skilled in the art recognizes that spread spectrum modulation describes distributing signals over a wide range of frequencies and then collecting them into their original frequency at the receiver. Spread spectrum uses wide band,

noise-like signals. Over the last 50 years, a class of modulation techniques usually called "spread spectrum," has been developed. This group of modulation techniques is characterized by its wide frequency spectra. The modulated output signals occupy a much greater bandwidth than the signal's baseband information bandwidth. To qualify as a spread spectrum signal, two criteria should be met: first, the transmitted signal bandwidth must be much greater than the information bandwidth, and second, some function other than the information being transmitted must be employed to determine the resultant transmitted bandwidth.

38. In contrast to spread spectrum modulation, one skilled in the art recognizes binary phase shift keying involves modulating a narrow band carrier wave. The modulation technique includes phase-shift keying (PSK) between two phase states, normally 180 degrees apart. Phase-shift keying is a form of modulation in which the phase of the carrier signal is shifted to represent digital data.

39. Stewart does not suggest, teach, or disclose binary phase shift keying. Those familiar with spread spectrum and binary phase shift keying recognize that spread spectrum is not at all similar to binary phase shift keying.

40. As of the filing date of Application Serial Number 09/779,076, one skilled in the art of proximity monitoring systems would not consider the use of binary phase shift keying as an obvious modulation technique.

41. In conclusion, Stewart teaches that three receiver, or sensor, coils are necessary (and, therefore, use of two coils is not obvious). Accordingly, Stewart's two generator coil/three sensor coil system does not render obvious the adequacy of a three generator coil/two sensor coil system. First, according to the discussion in paragraph 10, notwithstanding Stewart's assertions, Stewart's rendition of a three generator coil/two sensor coil system is not adequate for orientation independent performance in 3-dimensions. Also, as discussed in paragraph 21, according to Weinstein, a system with a single generator coil and three sensor coils is adequate if the sensor signals are nonlinearly combined and processed with a three-channel receiver. However, such a configuration is not obvious in view of Stewart. Neither is it obvious to have a configuration with three generating, or transmitting, coils or with two sensor, or receiving, coils.

42. The bottom line is that the performance of one particular generator/sensor system cannot be extrapolated to another simply on the basis of the number of coils used. Factors such as the manner of combining the sensor signals and the manner of driving the generator coils (rotating or non-rotating magnetic field, modulated or not modulated, etc.) must all be considered.

Respectfully submitted,

J. M. Rochelle

Dr. James M. Rochelle

9-26-03

Date